Chattanooga
Stream Corridor Evaluation (SCORE) Program

City of Chattanooga
Stormwater Management
Department of Public Works – Engineering

June 1, 2007

Executive Summary

The City of Chattanooga Stormwater Management Division proposes to identify stream channel stability problems in order to reduce sediment and nutrient loading from channel sources, improve in-stream habitat, protect public infrastructure, protect public and private property, and reduce the need for future channel maintenance in city streams. Such as program will satisfy Section II. C. 7.c.vi of the NPDES permit requiring a stream inspection program, and compliment Section V.C concerning Watershed Characterization and Modeling.

By following previously established corridor assessment protocols, and collecting and analyzing key physical, hydrologic, geologic, and biologic streambank parameters this program will evaluate and inventory stream corridor condition. Such qualifications and quantifications will allow stream reaches to be scored based on their respective severity and then transposed into a GIS inventory to subsequently allocate key resources more effectively. This planning document identifies two key areas where resources should be prioritized.

1.0 Introduction

The most frequently cited pollutant in Tennessee is sediment, impacting over 5,800 miles of state streams and rivers (TDEC 2006a). Within City of Chattanooga city limits and jurisdiction, approximately 85 linear miles of stream are listed as impaired due to sediment (TDEC 2006b). The TMDL for Siltation and Habitat Alteration for the Lower Tennessee River Watershed identified likely pollutant sources as land development, MS4 discharges, channelization, and hydromodification. The City of Chattanooga is dedicated to identifying, managing, and correcting this list of likely sources of sediment, specifically as they impact stream corridor condition. Obtaining site-specific knowledge of natural channel processes and conditions is a prerequisite for any stream engineering or restoration work.

Some bank erosion is natural and even healthy streams will display some evidence of sediment loss, especially at a stream's bend. However, tons of soil are lost every year as a result of land disturbing activities such as confined agriculture and construction. Streambank erosion may be accelerated in systems that have been hydraulically affected by changes in land-use, removal of riparian vegetation (buffers), and hydromodification. These stimuli may lead to additional sediment entering the stream network impacting water quality, quantity and stability. Some of the significant economic impacts caused by sediment are increased water treatment costs, loss of navigable channels, and increased likelihood of flooding.

1.1 Plan Purpose

Under the NPDES permit for the local MS4, the City of Chattanooga must implement stormwater management programs to reduce contaminants in the storm water to the "maximum extent practicable." The permit goes on to require in Section II. C. 7.c.vi that the permittee "shall develop and implement a stream inspection program to identify direct discharges to waters of the State…(via) the inspection of every accessible stream

segment". The proposed program to qualify and quantify streambank erosion is through preventative measures, and is presented in this planning document.

The City of Chattanooga Stormwater Management Division proposes to identify and correct stream channel stability problems in order to reduce sediment and nutrient loading from channel sources, improve in-stream habitat, protect public infrastructure, protect public and private property, and reduce the need for future channel maintenance in city streams.

Preventive planning in land development or alteration projects can protect streams from excess silt and protect valuable topsoil. Best Management Practices (BMPs) such as the installation of silt fences and maintenance of trees and undergrowth as buffer zones along creek banks can prevent or retard soil from entering the creek. Restoration and stabilization projects or BMPs should often be precluded by empirically-derived, formulaic stream corridor assessments.

1.2 Scope and Objectives

Proper management decisions, and ultimately corrections, stem from accurate identification, qualification, or quantification of the problem(s). Time and financial constraints often occlude land managers and planners from establishing and implementing streambank assessment programs. However, it is important to recognize that such an investment may produce substantial efficiency gains later. Accurate evaluations of bank condition and erosion potential will help support management decisions and strategies. Conversely, this can help avoid implementing ineffective bank management strategies, overdesigning bank structures that generate unnecessary expenditures and impacts, and underdesigning structures that may ultimately fail. Additionally, such assessments may help prioritize management efforts and planning locations.

This planning document is designed to supplement previously established survey protocols derived from in-house specialists and other jurisdictional agencies around the nation. This survey and inventory will provide a method which can be used to both efficiently assess the general physical condition of a stream system and identify or prioritize the location of potential environmental problems within the stream corridor. As such, this approach should be used as a tool for identifying restoration opportunities within City of Chattanooga's drainage network.

The major objective of this stream corridor evaluation program will be to collect and collate reliable and complete data to assess local watershed condition so as management and restoration resources may be better allocated. Collected data will specifically be used for 1) developing an inventory of problematic stream banks within the City of Chattanooga, 2) conducting rapid assessments of city streambanks for which personnel may later thoroughly address, 3) establishing pre- and post-restoration water quality studies within city waters, and 4) inclusion and application in to the city's watershed characterization and modeling programs.

2.0 Implementation and Approach

The predominant processes of streambank erosion include: surface erosion, mass failure (sheet and planar), fluvial entrainment (particle detachment by flowing water), freeze-thaw cycles, bank collapse, positive water pressure, both saturated and unsaturated failures, and hydraulic and gravitational forces (Rosgen 2001). These processes have been and continue to be studied providing better understanding of the complexities involved. The individual and collective consequences of each physical process of erosion however preclude consistent and reliable streambank erosion indices or predictions. Additionally, the mechanisms controlling the rate of streambank erosion and sediment transport listed above are difficult to model with usable accuracy.

A detailed and consistent approach to bank evaluation is the basis for sound identification and characterization of the site and any given problem associated. The State of Tennessee does not, at time of publication, have, or publicly promote, any standardized stream corridor evaluation protocol. However, a highly regarded and commonly employed survey protocol has been composed by the Maryland Department of Natural Resources (Yetman 2001), which will serve as the format which City of Chattanooga personnel will follow. This assessment protocol provides a basic level of stream and streambank health evaluation based primarily on visual observations of each stream reach condition. It is designed to be applied by personnel with basic biological or hydrological training. Because of this relative simplicity, the methodology may be performed quickly; however it may not detect some resource problems caused by factors not located immediately beyond the area being evaluated.

2.1 Protocols

Data needs for streambank assessment vary depending on the scope and nature of the project, but in general it is necessary to compile sufficient data to allow the planner or design team to formulate an understanding of the processes or stimuli occurring at the site and within its basin. The proposed stream corridor evaluation protocol should be practical (essential measurements obtainable with minimal effort) and general (the method may be applied under most any reasonable set of conditions). Above all, the purpose of a stream corridor evaluation is to identify unstable stream reaches that are experiencing a significant amount of erosion along the stream's banks. At least some level of understanding, qualification and quantification must exist for the various ecosystem components: physical, hydrologic, geologic, and biologic.

The physical conditions of any stream corridor allow each system to be unique. Data that describe the physical characteristics of a given stream reach include general site conditions such as water blockages via down woody debris, bank failure, or trash accumulation, sociologic factors such as adjacent land use, any infrastructure and problem areas such as exposed pipes or pipe outfalls, and the individual and cumulative impacts that these conditions create. The impacts from each of these on streambank condition and stability may be categorized by means of their respective material, condition, size, permanence, proximity to the waterway, likely severity, potential correctability, and discharge or loading potential.

Understanding the hydrologic character of a stream is an absolute requirement for successful implementation of virtually any restoration or streambank stability project. Key water quality and quantity characteristics should be obtained for the following parameters: odor, algal deposits, sheen, color, riffles, floatables, and flow. For the purpose of this rapid evaluation, the presence or lack of presence for these variables is considered sufficient, and may be obtained with relative ease. These parameters are often considered effective indicators for a number of other variables and will help define the overall condition of the stream reach as it relates to the adjacent stream corridor. This initial analysis will provide a basis for prioritization of subsequent evaluations.

Geologic investigations define the underlying rock line and provide basic information on channel morphology, alluvial deposits, bank stability, construction and structure suitability, soil properties, and the influence of these on each other and other streambank variables. Geologic evaluations also provide information on the quantity and quality of sediment available for transport, e.g. grain particle size. Streambank and bed material dictate the location, path, and rate of bank failure, entrenchment, aggradation, and degradation. To this end, data will need to be collected on channel cross-sectional geometry, bed material and soil type (from which particle size, permeability, drainage potential, and erodibility may later be derived).

Biologic indicators for the purpose of the stream corridor assessment will primarily focus on the vegetation condition surrounding and overhanging the waterway, rather than quantifying in-stream habitat quality. Riparian characteristics will help define longitudinal erosion and loading rates and volumes from surrounding lands, and canopy characteristics help define rainfall energy and wash loading. Proposed vegetation parameters to be quantified include width and density of riparian condition on surrounding bank, percent canopy over the waterway, and if applicable, the type and quality of surrounding vegetation, both grass and woody.

It is suggested that the successful compilation of the aforementioned parameters will allow for scoring or ranking of individual stream corridors into varying levels of severity. Survey members must use their professional judgement to determine the severity of certain parameters to classify (un)stable stream channels and if there is, or there is the potential to be, an environmental problem. Stream reaches that score well for the different proposed indices will cumulatively score as a minor area. Corridors that score poorly on the individual indices will ultimately rank as severe areas.

Finalized local protocols, data sheets, scoring indices, and scoring severity will need to be defined, approved and supported by City of Chattanooga Stormwater Water Quality personnel. Reference, or baseline, stream corridor examples may also need to be provided so as all water quality staff may objectively evaluate stream corridor condition.

2.2 Priority Areas

Although a complete inventory and scoring of city wide stream corridors is proposed to be conducted, an initial focus will be set upon two areas within the City of Chattanooga: Citico Creek and Friar Branch of South Chickamauga Creek (Figure 2.1). A completed stream corridor evaluation and inventory for the above priority areas should serve as a launching pad for other areas and efforts within the City of Chattanooga. These

prioritized campaigns will also allow city personnel to evaluate survey and inventory techniques, identify knowledge gaps, improve scoring systems, and identify reference reaches against which other streams may be compared.

Figure 2.1. Map of City of Chattanooga streams, with priority areas for stream corridor evaluations displayed in red.

2.2.1 Citico Creek

The 2006 303(d) list for the Lower Tennessee River Watershed (HUC TN06020001), the waterbody into which Citico Creek deposits, cites 7.4 river miles of Citico as impaired due to, among other things, siltation leading to loss of biological integrity (TDEC 2006a). Under Section V.C. of the MS4 NPDES permit for the City of Chattanooga, the city is required to collect necessary data to define water quality and hydrologic characteristics of a priority city watershed – Citico Creek watershed. Additionally, the same section requires city personnel to perform modeling activities to establish the nature and quantity of nonpoint source pollutants in the watershed. It has been suggested through preliminary watershed characterization and modeling exercises that such data are incomplete or require verification. A stream corridor evaluation priority has thus been placed upon Citico Creek to compliment and contribute to watershed characterization and simulation studies conducted by the City of Chattanooga.

Watershed characterization efforts for Citico Creek yielded preliminary findings of streambank length, but not condition. Evaluations of these areas will contribute to successful satisfaction of the NPDES permit. Similarly, preliminary nonpoint source pollutant modeling of sediment could not be satisfactorily completed because streambank contributions were omitted due to lack of adequate condition data. The most direct method to estimate streambank erosion is summarized as:

$$A = (EA \times LRR \times SBD) / 2000$$

Where:

A = Erosion in tons per year
EA = Eroding Area, usually as ft^2, or acre
LRR = Lateral Recession Rate, in feet per year
SBD = Soil Bulk Density, in pounds per ft^3

Eroding area may be estimated as a product of stream corridor length and stream bank height, collected through field surveys and GIS analyses. Recession rate is generally collected over a period of six months to one year by means of permanent profile rods/plots. The present approach, rather than beginning a lengthy profile survey, will build upon existing data and research on streambank erosion, channel geometry and hydraulics, and transport rates and resistance. Estimations of recession rates will stem from data collected from field stream corridor evaluations, generally as a conditional function of stream bank, stream bed, vegetation, water, and land use (as defined above). Local soil densities may be collected or inferred from general soil properties via the Hamilton County Soil Survey (USDA 1982) following site evaluation for bed and bank material and GIS exercises.

The previously submitted Citico Creek Simulation Plan suggested that initial or additional stream corridor assessments will be required for both watershed characterizations and sediment loading model development. This document proposed such evaluations for all natural or earthen channels throughout the length of the stream, or 7.8 miles (to be verified). An additional 4.5 miles of Citico is estimated to be concrete ditch. The stream corridor evaluation rate for Citico Creek was proposed at 5,920 ft per month for seven months from June through December 2007. This planning area is composed primarily of urban structures and passageways providing relative ease of access; therefore it is believed that this numerical goal is obtainable. It is assumed that successful completion of this analysis will satisfy knowledge gaps for stream corridor length and condition for Citico Creek.

2.2.2 Friar Branch

A second priority area for concentrated stream corridor evaluation efforts is the Friar Branch segment of South Chickamauga Creek. A total of 18.9 river miles of Friar Branch (HUC TN06020007-0100) is listed in the 2006 303(d) list due to siltation, likely stemming from land development and MS4 discharges. In an effort to lessen the existing impacts and mitigate any additional impacts, the City of Chattanooga, in cooperation with local landowners, and local, state, and federal conservation agencies, is in the process of restoring a near 5,000 linear foot segment of Friar Branch (Figure 2.2). The proposed restoration sections of the stream have previously been altered via channelization and hydromodification, leading to changes in channel geometry, baseflow, vegetation, and ultimately sedimentation rates and volumes.

Stream corridor data should be collected in and around the proposed restoration reaches of Friar Branch for use in subsequent pre- and post-restoration studies. The reestablishment of natural, meandering stream corridors provides an outstanding opportunity to evaluate the effectiveness of varying levels of meander, channel

dimension, vegetative buffer density and width, and bed material, among other things. It is thus proposed that stream corridor evaluations be conducted on the currently proposed 5,000 ft reach of the stream to be hydraulically engineered, plus an additional 3,100 ft downstream to Noah Reid Road, and 2,400 ft upstream to Standifer Gap Road. This two mile stretch may be adequately evaluated over the span of three months. Additional assessments upstream of Standifer Gap to the stream origin may also be beneficial to the overall corridor evaluation, providing an additional 11,500 ft of baseline data and three months of field surveys experience.

Figure 2.2. Conceptual design of the Friar Branch Restoration Project as of 4 April, 2007 (subject to change).

2.3 Planning Milestones

In order to meet time guidelines and project completion dates on other watershed projects conducted by the City of Chattanooga, this stream corridor evaluation program must be established by certain dates. The Citico Creek Watershed Simulation Plan is scheduled to be complete and submitted by May 2008, and the Friar Branch Restoration Project is estimated to begin by summer of 2008. As such, the opportunity to collect and analyze appropriate stream corridor data for these respective areas is limited. It is proposed that this project begin in June 2007 following administrative and logistic deliverables.

Proposed milestones and completion dates for successful establishment of the Chattanooga Stream Corridor Evaluation program are presented in Table 2.1. The Citico Creek Watershed Simulation Plan proposed a stream corridor evaluation progress rate of 5,920 linear feet per month, and assessments to be completed by December 2007.

Stream corridor evaluations for Friar Branch may run concurrent to or following these dates and should be completed by May 2008. Additioinal priority areas will be identified and efforts focused at this time. It is proposed that a performance measure of 10,000 linear feet of stream corridor evaluation per month be met, totaling over 22 miles of corridor evaluation per year. Consultation with City of Chattanooga water quality staff confirmed that this measure should be met, or surpassed, as local protocols are mastered.

Table 2.1. Proposed milestones and completion dates for successful establishment of the Chattanooga Stream Corridor Evaluation program.

Milestone	Anticipated Completion
Develop a user-friendly Stream Corridor Evaluation Data Sheet	Jun-07
Develop a training presentation/ demonstration to water quality staff.	Jun-07
Complete Stream Corridor Evaluation for Citico Creek.	Dec-07
Incorporate Inventory and Evaluation data into Citico Creek Watershed Simulation Plan	Dec-07
Complete Stream Corridor Evaluation for priority areas along Friar Branch.	May-08

3.0 Expected Outcomes

As defined in Section 1 above, the primary objective of this stream corridor evaluation program is to assess local watershed condition to improve management and restoration decisions. It is anticipated that the successful completion of this program will ultimately aid in developing City of Chattanooga ordinances along city waterways to prevent or reduce sedimentation problems to delist city rivers from the Tennessee 303(d) list and to ensure that no other local waterways are included on this list.

Other expected outcomes of this program include satisfying Section II. C. 7.c.vi of the NPDES permit requiring a stream inspection program, and Section V.C., (Priority) Watershed Characterization and Watershed Modeling by means of developing a GIS inventory of local stream corridor condition. Evaluation activities will also allow water quality staff to survey for illicit discharge activities, stormwater quality control structures, flood control structures, and industrial and construction runoff best management practices.

4.0 References

Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Interagency Sedimentation Conference, Vol. 2.

TDEC 2004. Stream Mitigation Guidelines for the State of Tennessee. Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

TDEC 2006a. Year 2006 303(d) List, Proposed Final Version. State of Tennessee, Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

TDEC 2006b. Total Maximum Daily Load for Siltation and Habitat Alteration in the Lower Tennessee River Watershed, Bledsoe, Bradley, Hamilton, Loudon, Marion, McMinn, Meigs, Rhea, Roane, and Sequatchie Counties, Tennessee.

USDA. 1982. Soil survey of Hamilton County, Tennessee.

Yetman, K.T. 2001. Stream Corridor Assessment Survey. Maryland Department of Natural Resources. Watershed Restoration Division.